Claims:

1. A process for selectively extracting metal values from a starting material which includes one or more solubilizable metal values, the process comprising:

separating and removing fluorine values from the starting material;

leaching the remaining material to solubilize metal values contained in the remaining material and generate an aqueous solution comprising said solubilized metal values; and

extracting a solubilized metal value from said aqueous solution.

2. The process of claim 1 wherein the step of separating and removing fluorine values comprises:

reacting the starting material with a solution of a mineral acid for a period of time, and under temperature and pressure conditions sufficient to solubilize at least a portion of tantalum and niobium from the starting material;

separating and drying the undissolved material;

reacting the undissolved material with mineral acid comprising sulfuric acid for a period of time, and under temperature and pressure conditions sufficient to liberate hydrogen fluoride gas and to generate a sulfated material.

3. The process of claim 2 wherein the step of leaching the undissolved material to solubilize metal values contained in the undissolved material and generate an aqueous solution comprising said solubilized metal values comprises:

reacting the sulfated material with water for a period of time, and under temperature and pressure conditions sufficient to generate said aqueous solution comprising solubilized metal values;

filtering said aqueous solution to separate remaining material solids from said aqueous solution.

4. The process of claim 3 wherein the aqueous solution includes zirconium and uranium and the step of extracting a solubilized metal value from said aqueous solution comprises extracting zirconium and uranium metal values by a process comprising:

contacting said aqueous solution with an organic medium which includes a diluent and an extractant, said diluent being immiscible with said aqueous solution thereby producing an organic phase comprising zirconium and uranium and an aqueous raffinate phase;

separating said organic phase from said raffinate phase;

stripping zirconium from said organic phase by contacting said organic

phase with a zirconium stripping agent, the zirconium stripping forming an aqueous phase comprising zirconium and a resultant organic phase comprising uranium; and

stripping uranium from said resultant organic phase by contacting said resultant organic phase with a uranium stripping agent, the uranium stripping forming an aqueous phase comprising uranium and a final organic phase comprising said diluent and said extractant.

5. The process of claim 4 wherein the aqueous solution includes uranium, zirconium, thorium and scandium and the process further comprises extracting thorium and scandium metal values from said raffinate formed by said contact between said aqueous solution and said organic medium, by a process comprising:

contacting said raffinate with another organic medium which includes a diluent and an extractant, said diluent being immiscible with said aqueous solution, thereby producing an organic phase comprising thorium and scandium and an another aqueous raffinate phase;

separating said organic phase from said another raffinate phase;

stripping thorium from said organic phase by contacting said organic phase with a thorium stripping agent, said thorium stripping forming an aqueous phase comprising thorium and a resultant organic phase comprising scandium; and

stripping scandium from said resultant organic phase by contacting said resultant organic phase with a scandium stripping agent, said scandium stripping forming a phase comprising scandium from said resultant organic phase and an aqueous phase comprising said scandium stripping agent and a final organic phase.

6. The process of claim 4 wherein said organic medium further comprises a modifier.

7. The process of claim 5 wherein said another organic medium further comprises a modifier.

8. A process for selectively extracting zirconium, uranium, thorium and scandium metal values from a starting material which includes the metal values comprising:

reacting a starting material with a solution of a mineral acid for a period of time, and under temperature and pressure conditions sufficient to solubilize tantalum and niobium into solution and thereby generate a solution comprising tantalum and niobium, and a remaining material;

separating and drying the remaining material;

reacting the remaining material with mineral acid for a period of time, and under temperature and pressure conditions sufficient to liberate hydrogen fluoride gas and to generate a sulfated material;

reacting (leaching) the sulfated material with water for a period of time, and under temperature and pressure conditions sufficient to generate an aqueous solution of the metal values;

filtering said aqueous solution to separate remaining material solids from the aqueous solution;

contacting said aqueous solution with an organic medium which includes a diluent and an extractant, and preferably further includes a modifier, said diluent being immiscible with said aqueous solution thereby producing an organic phase comprising zirconium and uranium and an aqueous raffinate phase depleted in zirconium and uranium;

separating said organic phase from said raffinate phase;

stripping zirconium from said organic phase by contacting said organic phase with a zirconium stripping agent, said stripping forming a zirconium aqueous phase comprising zirconium from said organic phase and a resultant organic phase comprising uranium, said diluent and said extractant; and

stripping uranium from said resultant organic phase by contacting said resultant organic phase with a uranium stripping agent, said stripping forming a uranium aqueous phase comprising uranium from said resultant organic phase and a final organic phase comprising said diluent and said extractant.

contacting said raffinate with another organic medium which includes a diluent and an extractant, and preferably further includes a modifier, said diluent being immiscible with said raffinate, thereby producing an organic phase comprising thorium and scandium and an another raffinate phase depleted in thorium and scandium;

separating said organic phase from said raffinate phase;

stripping thorium from said organic phase by contacting said organic phase with a thorium stripping agent, said stripping forming a thorium aqueous phase comprising thorium from said organic phase and another resultant organic phase comprising scandium, said diluent and said extractant; and

stripping scandium from said another resultant organic phase by contacting said resultant organic phase with a scandium stripping agent, said stripping forming a scandium phase comprising scandium from said resultant organic phase, an aqueous phase comprising said scandium stripping agent and another final organic phase comprising said diluent and said extractant.

9. A process for selectively extracting zirconium, uranium, thorium and scandium metal values from a sulfated starting material which includes the metal values comprising:

reacting (leaching) the starting sulfated material with water for a period of time, and under temperature and pressure conditions sufficient to generate an aqueous solution of the metal values;

filtering said aqueous solution to separate remaining material solids from the aqueous solution;

contacting said aqueous solution with an organic medium which includes a diluent and an extractant, and preferably further includes a modifier, said diluent being immiscible with said aqueous solution thereby producing an organic phase comprising zirconium and uranium and an aqueous raffinate phase depleted in zirconium and uranium;

separating said organic phase from said raffinate phase;

stripping zirconium from said organic phase by contacting said organic phase with a zirconium stripping agent, said stripping forming a zirconium aqueous phase comprising zirconium from said organic phase and a resultant organic phase comprising uranium, said diluent and said extractant; and

stripping uranium from said resultant organic phase by contacting said resultant organic phase with a uranium stripping agent, said stripping forming a uranium aqueous phase comprising uranium from said resultant organic phase and a final organic phase comprising said diluent and said extractant.

contacting said raffinate with another organic medium which includes a diluent and an extractant, and preferably further includes a modifier, said diluent being immiscible with said raffinate, thereby producing an organic phase comprising thorium and scandium and an another raffinate phase depleted in thorium and scandium;

separating said organic phase from said raffinate phase;

stripping thorium from said organic phase by contacting said organic phase with a thorium stripping agent, said stripping forming a thorium aqueous phase comprising thorium from said organic phase and another resultant organic phase comprising scandium, said diluent and said extractant; and

stripping scandium from said another resultant organic phase by contacting said resultant organic phase with a scandium stripping agent, said stripping forming a scandium phase comprising scandium from said resultant organic phase, an aqueous phase comprising said scandium stripping agent and another final organic phase comprising said diluent and said extractant.

selectively extracting a solubilized metal value from said aqueous solution.

2. (Once Amended) The process of claim 1 wherein the one or more solubilizable metal values include tantalum and niobium and the step of separating and removing fluorine values further comprises:

reacting the source [starting] material with a solution of a mineral acid for a period of time, and under temperature and pressure conditions sufficient, to solubilize at least a portion of tantalum and niobium from the source [starting] material and create a solution comprising tantalum and niobium metal values and undissolved material;

separating and drying the undissolved material;

reacting the undissolved material with a mineral acid comprising sulfuric acid for a period of time, and under temperature and pressure conditions sufficient to liberate hydrogen fluoride gas and to generate a sulfated material comprising the one or more other solubilizable metal value(s) and at least partially depleted in fluorine metal values; and

leaching the sulfated material to solubilize the one or more other metal values contained in the sulfated material and generate said aqueous solution comprising the solubilizable metal value(s) and a solid phase at least partially depleted in the solubilizable metal value(s).

3. (Once amended) The process of claim 2 wherein the step of leaching the sulfated [undissolved] material [to solubilize metal values contained in the ~~undissolved~~ sulfated material and generate an aqueous solution comprising said solubilized metal values] comprises:

reacting the sulfated material with water for a period of time, and under temperature and pressure conditions sufficient to generate said aqueous solution comprising the one or more other solubilized metal values; and

filtering said aqueous solution comprising the one or more other solubilized metal values to separate remaining material solids from said aqueous solution.

4. (Once Amended) The process of claim 3 wherein the one or more other solubilizable metal values in the aqueous solution include[s] zirconium and uranium metal values, and the process further includes [step of extracting a solubilized metal value from said aqueous solution comprises] extracting zirconium and uranium metal values by a process comprising:

contacting said aqueous solution with an organic medium which includes a diluent and an extractant, said diluent being immiscible with said aqueous solution thereby producing an organic phase comprising zirconium and uranium metal values and an aqueous raffinate phase at least partially depleted in zirconium and uranium metal values;

separating said organic phase from said raffinate phase;

stripping zirconium from said organic phase by contacting said organic phase with a zirconium stripping agent, the zirconium stripping forming an aqueous phase comprising zirconium and a resultant organic phase comprising uranium; and

stripping uranium from said resultant organic phase by contacting said resultant organic phase with a uranium stripping agent, the uranium stripping forming an aqueous phase comprising uranium and a final organic phase comprising said diluent and said extractant.

5. (Once amended) The process of claim 4 wherein the one or more other solubilizable metal values in the aqueous solution further includes uranium, zirconium, thorium and scandium metal values and the process further comprises extracting thorium and scandium metal values from said raffinate phase at least partially depleted in zirconium and uranium metal values formed by said contact between said aqueous solution and said organic medium, by a process comprising:

contacting said raffinate phase with another organic medium which includes a diluent and an extractant, said diluent being immiscible with said aqueous solution, thereby producing an organic phase comprising thorium and scandium metal values and an another aqueous raffinate phase at least partially depleted in thorium and scandium metal values;

separating said organic phase from said another raffinate phase;

stripping thorium from said organic phase by contacting said organic phase with a thorium stripping agent, said thorium stripping forming an aqueous phase comprising thorium and a resultant organic phase comprising scandium; and

stripping scandium from said resultant organic phase by contacting said resultant organic phase with a scandium stripping agent, said scandium stripping forming a phase comprising scandium from said resultant organic phase and an aqueous phase comprising said scandium stripping agent and a final organic phase.

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8. (Once Amended) A process for selectively extracting zirconium, uranium, thorium and scandium metal values from a source [starting] material comprising zirconium, uranium,

thorium, scandium, fluorine, tantalum and/or niobium [which includes the] metal values the process comprising:

reacting the source [a starting] material with a solution of a mineral acid for a period of time, and under temperature and pressure conditions sufficient to solubilize tantalum and niobium into solution and thereby generate a solution comprising tantalum and/or niobium metal values, and a remaining material at least partially depleted in tantalum and/or niobium and comprising fluorine, zirconium, uranium, thorium and/or scandium metal values;

separating and drying the remaining material;

A2 cont.

reacting the remaining material with mineral acid for a period of time, and under temperature and pressure conditions sufficient to liberate hydrogen fluoride gas and to generate a sulfated material at least partially depleted in fluorine metal values and comprising zirconium, uranium, thorium and/or scandium metal values;

reacting (leaching) the sulfated material with water for a period of time, and under temperature and pressure conditions sufficient to generate an aqueous solution comprising zirconium, uranium, thorium and/or scandium [of the] metal values;

filtering said aqueous solution comprising zirconium, uranium, thorium and/or scandium metal values to separate remaining material solids from the aqueous solution;

contacting said aqueous solution comprising zirconium, uranium, thorium and/or scandium metal values with an organic medium which includes a diluent and an extractant [, and preferably further includes a modifier,] said diluent being immiscible with said aqueous solution thereby producing an organic phase comprising zirconium and/or uranium metal values and an

aqueous raffinate phase at least partially depleted in zirconium and uranium metal values and comprising thorium and/or scandium metal values;

separating said organic phase comprising zirconium and/or uranium metal values from said raffinate phase at least partially depleted in zirconium and/or uranium metal values and comprising thorium and/or scandium metal values;

stripping zirconium from said organic phase comprising zirconium and/or uranium metal values by contacting said organic phase with a zirconium stripping agent, said stripping forming a zirconium aqueous phase comprising zirconium metal values from said organic phase and at least partially depleted in uranium metal values and a resultant organic phase comprising uranium, said diluent and said extractant; and

A2 Cont.

stripping uranium from said resultant organic phase by contacting said resultant organic phase with a uranium stripping agent, said stripping forming a uranium aqueous phase comprising uranium from said resultant organic phase and a final organic phase comprising said diluent and said extractant.

contacting said raffinate phase at least partially depleted in zirconium and/or uranium metal values and comprising thorium and/or scandium metal values with another organic medium which includes a diluent and an extractant, [and preferably further includes a modifier,] said diluent being immiscible with said raffinate, thereby producing an organic phase comprising thorium and/or scandium metal values and an another raffinate phase at least partially depleted in thorium and/or scandium metal values;

separating said organic phase comprising thorium and/or scandium metal values from said raffinate phase at least partially depleted in thorium and/or scandium metal values;

stripping thorium from said organic phase comprising thorium and/or scandium metal values by contacting said organic phase with a thorium stripping agent, said stripping forming a thorium aqueous phase comprising thorium metal values from said organic phase and at least partially depleted in scandium metal values and another resultant organic phase comprising scandium metal values, said diluent and said extractant; and

stripping scandium metal values from said another resultant organic phase by contacting said resultant organic phase with a scandium stripping agent, said stripping forming a scandium phase comprising scandium from said resultant organic phase, an aqueous phase comprising said scandium stripping agent and another final organic phase comprising said diluent and said extractant.

A2 cont.

9. (Once Amended) A process for selectively extracting zirconium, uranium, thorium and scandium metal values from a sulfated starting material which includes the metal values comprising:

reacting [(leaching)] the sulfated material with water for a period of time, and under temperature and pressure conditions sufficient to generate an aqueous solution comprising zirconium, uranium, thorium and/or scandium [of the] metal values;

filtering said aqueous solution comprising zirconium, uranium, thorium and/or scandium metal values to separate remaining material solids from the aqueous solution;

contacting said aqueous solution comprising zirconium, uranium, thorium and/or scandium metal values with an organic medium which includes a diluent and an extractant [, and preferably further includes a modifier,] said diluent being immiscible with said aqueous solution

thereby producing an organic phase comprising zirconium and/or uranium metal values and an aqueous raffinate phase at least partially depleted in zirconium and uranium metal values and comprising thorium and/or scandium metal values;

separating said organic phase comprising zirconium and/or uranium metal values from said raffinate phase at least partially depleted in zirconium and/or uranium metal values and comprising thorium and/or scandium metal values;

stripping zirconium from said organic phase comprising zirconium and/or uranium metal values by contacting said organic phase with a zirconium stripping agent, said stripping forming a zirconium aqueous phase comprising zirconium metal values from said organic phase and at least partially depleted in uranium metal values and a resultant organic phase comprising uranium, said diluent and said extractant; and

A2 cont.

stripping uranium from said resultant organic phase by contacting said resultant organic phase with a uranium stripping agent, said stripping forming a uranium aqueous phase comprising uranium from said resultant organic phase and a final organic phase comprising said diluent and said extractant.

contacting said raffinate phase at least partially depleted in zirconium and/or uranium metal values and comprising thorium and/or scandium metal values with another organic medium which includes a diluent and an extractant, [and preferably further includes a modifier,] said diluent being immiscible with said raffinate, thereby producing an organic phase comprising thorium and/or scandium metal values and an another raffinate phase at least partially depleted in thorium and/or scandium metal values;

separating said organic phase comprising thorium and/or scandium metal values from said raffinate phase at least partially depleted in thorium and/or scandium metal values;

stripping thorium from said organic phase comprising thorium and/or scandium metal values by contacting said organic phase with a thorium stripping agent, said stripping forming a thorium aqueous phase comprising thorium metal values from said organic phase and at least partially depleted in scandium metal values and another resultant organic phase comprising scandium metal values, said diluent and said extractant; and

stripping scandium metal values from said another resultant organic phase by contacting said resultant organic phase with a scandium stripping agent, said stripping forming a scandium phase comprising scandium from said resultant organic phase, an aqueous phase comprising said scandium stripping agent and another final organic phase comprising said diluent and said extractant.

In addition please add the following new claims 10-15.

10. (New) A process for selectively extracting a scandium metal value from a source material which includes solubilizable scandium metal values, the process comprising:

leaching the source material to solubilize scandium metal values contained in the source material and generate an aqueous solution comprising said solubilized scandium metal values and a solid phase at least partially depleted in scandium; and

selectively extracting a scandium metal value from said aqueous solution.

11. (New) The process of claim 10 wherein the source material further comprises fluorine, tantalum and/or niobium and the process further comprises:

reacting the source material with a solution of a mineral acid for a period of time, and under temperature and pressure conditions sufficient, to solubilize at least a portion of tantalum and niobium from the starting material and create a solution comprising tantalum and niobium metal values and a solids residue comprising fluorine and scandium metal values, and at least partially depleted in tantalum and niobium metal values;

separating and drying the solids residue

reacting the solids residue with a mineral acid comprising sulfuric acid for a period of time, and under temperature and pressure conditions sufficient, to liberate hydrogen fluoride gas and to generate a sulfated material comprising scandium metal values and at least partially depleted in fluorine metal values; and

leaching the sulfated material to solubilize scandium metal values contained in the sulfated material and generate said aqueous solution comprising scandium metal values and a solid phase at least partially depleted in scandium.

12. (New) The process of claim 11 wherein the step of leaching the sulfated material comprises:

reacting the sulfated material with water for a period of time, and under temperature and pressure conditions sufficient to generate said aqueous solution comprising solubilized scandium metal values; and

filtering said aqueous solution comprising solubilized scandium metal values to separate remaining material solids from said aqueous solution.

13. (New) The process of claim 12 wherein the step of selectively extracting a scandium metal value from said aqueous solution comprising solubilized scandium metal values comprises:

contacting said aqueous solution comprising solubilized scandium metal values with an organic medium which includes a diluent and an extractant, said diluent being immiscible with said aqueous solution, thereby producing an organic phase comprising scandium metal values and an aqueous raffinate phase at least partially depleted in scandium metal values;

separating said organic phase from said raffinate phase;

stripping scandium from said organic phase by contacting said organic phase with a scandium stripping agent, said scandium stripping forming a phase comprising scandium from said resultant organic phase and an aqueous phase comprising said scandium stripping agent and a final organic phase.

14. (New) A process for selectively extracting scandium metal values from a source material comprising scandium, fluorine, tantalum and/or niobium metal values the process comprising:

reacting the source material with a solution of a mineral acid for a period of time, and under temperature and pressure conditions sufficient to solubilize tantalum and niobium into solution and thereby generate a solution comprising tantalum and/or niobium metal values, and a

remaining material at least partially depleted in tantalum and/or niobium and comprising fluorine and/or scandium metal values;

separating and drying the remaining material;

reacting the remaining material with mineral acid for a period of time, and under temperature and pressure conditions sufficient to liberate hydrogen fluoride gas and to generate a sulfated material at least partially depleted in fluorine metal values and comprising scandium metal values;

reacting the sulfated material with water for a period of time, and under temperature and pressure conditions sufficient to generate an aqueous solution scandium metal values;

filtering said aqueous solution comprising scandium metal values to separate remaining material solids from the aqueous solution;

contacting said aqueous solution comprising solubilized scandium metal values with an organic medium which includes a diluent and an extractant, said diluent being immiscible with said aqueous solution, thereby producing an organic phase comprising scandium metal values and an aqueous raffinate phase at least partially depleted in scandium metal values;

separating said organic phase comprising scandium metal values from said raffinate phase at least partially depleted in scandium metal values;

stripping scandium metal values from said organic phase by contacting said resultant organic phase with a scandium stripping agent, said stripping forming a scandium phase comprising scandium metal values from said organic phase, an aqueous phase comprising said scandium stripping agent and a final organic phase comprising said diluent and said extractant.

15. (New) A process for selectively extracting scandium metal values from a sulfated starting material which includes the metal values comprising:

reacting the sulfated material with water for a period of time, and under temperature and pressure conditions sufficient to generate an aqueous solution comprising scandium metal values;

filtering said aqueous solution comprising scandium metal values to separate remaining material solids from the aqueous solution;

contacting said aqueous solution comprising solubilized scandium metal values with an organic medium which includes a diluent and an extractant, said diluent being immiscible with said aqueous solution, thereby producing an organic phase comprising scandium metal values and an aqueous raffinate phase at least partially depleted in scandium metal values;

separating said organic phase comprising scandium metal values from said raffinate phase at least partially depleted scandium metal values;

stripping scandium metal values from said organic phase by contacting said resultant organic phase with a scandium stripping agent, said stripping forming a scandium phase comprising scandium metal values from said organic phase, an aqueous phase comprising said scandium stripping agent and a final organic phase comprising said diluent and said extractant.

The following remarks are submitted in response to the Office Action mailed May 28, 1997.